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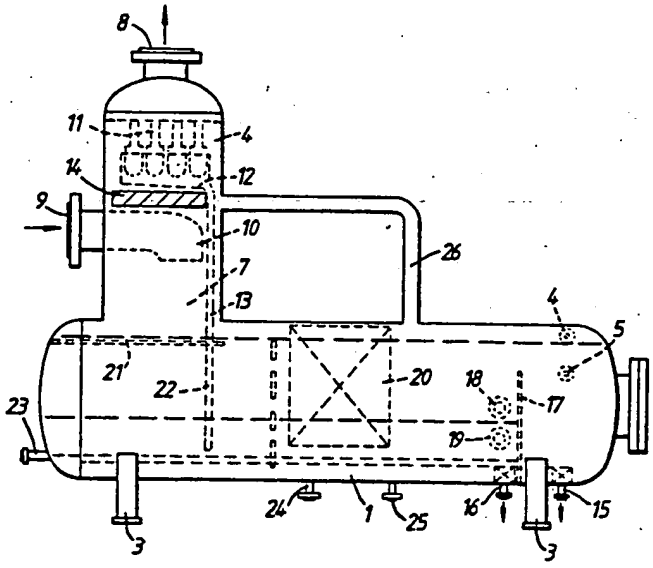

(57) Abstract

A separator for treating gas carrying entrained water and hydrocarbon liquid comprises a horizontal vessel (2) and a vertical vessel (7). Liquid level in the horizontal vessel is controlled so that the horizontal vessel is substantially filled with liquid. Gas with entrained liquid particles enters the vessel (7) via an inlet diffuser (10) which directs the inlet flow downwardly within the vessel (7). Gas and entrained liquid particles then flow upwardly past the diffuser (10) through an agglomerator (14) into a multicyclone bundle in which liquid and solid particles are removed. Within the horizontal vessel aqueous material separates to the bottom of the vessel and is removed via an outlet (16) whilst hydrocarbon material flows over a weir (17) and is removed via an outlet (15).

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THREE PHASE SEPARATOR

This invention relates to a three phase separator design and in the preferred embodiment provides a separator suitable for separating gas, hydrocarbon liquid and water emanating from a crude oil well.

It is conventional to separate the gas, hydrocarbon and aqueous phases of fluid emanating from an oil well by means of a closed horizontal vessel which, in use, is approximately half filled with liquid to provide a substantial space at the top of the vessel in which liquid particles may disengage from the gaseous phase.

Such separators must be of substantial size, and, becuase of the large free space above the liquid are susceptible to the formation of waves in the liquid phases due to flow surges or movement of the vessel.

According to the present invention a three phase separator comprises a first, lower, vessel which in use is substantially filled with liquid and a second, upper, vessel, mounted atop and in communication with the lower vessel, in which liquid/gas disengagement is effected, the maximum cross-sectional area of the upper vessel, measured in the horizontal plane, being smaller than the maximum cross-sectional area of the lower vessel, measured in the horizontal plane.

In the preferred embodiment of the invention the upper vessel is a substantially cylindrical vessel mounted with its axis vertical. Incoming crude oil enters the

vertical vessel horizontally through an inlet diffusing device containing baffles and/or vanes: this diffuser directs the gas and liquid generally downward into an area where the bulk of the liquid passes downwards into the lower vessel, and the gas together with small entrained droplets or foam passes upwards past the inlet diffuser into the upper section of the vertical vessel.

The invention will be better understood from the following description of preferred embodiments thereof, given by way of example only, reference being had to the accompanying drawings wherein:

Figure 1 illustrates schematically in cross-section a first preferred embodiment of the invention; and

Figure 2 illustrates a second preferred embodiment of the invention.

The three phase separator 1 shown in the drawing comprises a lower horizontal cylindrical vessel 2 mounted on legs 3. In use, the rate at which liquid is removed from the vessel is controlled by level sensors 4,5 so that the vessel is maintained substanially filled with liquid, a typical working liquid level being indicated at 6 in the drawing. Mounted atop the horizontal vessel 2 at one end thereof is an upper cylindrical vertically extending vessel 7. The vessel 7 extends from the upper surface of the vessel 2 upwardly to a gas outlet 8 defined at the top end of the vertical vessel. An inlet passage 9 extends through the wall of the vertical vessel 7 and terminates in an inlet diffuser 10 which directs gas and liquid from the inlet passage 9 downwardly in the vessel 7 towards the surface 7 of th liquid in the horizontal vessel 2.

After flowing initially downwardly from the diffuser 10, gas with ntrained liquid droplets or foam, flows upwardly in the vessel 7 past the inlet diffuser

10 to a separator 11 mounted in the upper portion of the vertical vessel 7. Within this separator the gas and entrained liquid or foam are separated. The separator may be of any suitable form, and may for example be a bundle of multicyclone separators as illustrated, or may be a chevron vane separator, or may be of any other suitable form. In the preferred multicyclone separators entrained liquids and solids are subjected to a spinning action causing collapse of any foam, and throwing liquids and solids to the walls of the cyclone tubes. Liquid and solids from the cyclone tubes drain out into a collecting hopper 12 which is connected by a drain-pipe 13 either to The horizontal vessel or to a small separate storage tank. Gas, substantially free from entrained liquids and solids, passes outwardly through the outlet 8.

Optionally, an agglomerator 14 is located in The path of upwardly flowing gas before the gas enters the separator. The agglomerator may be of any suitable type, and may for example consist of wire mesh or a plurality of closely spaced plates. In passing through the agglomerator any very small dispersed droplets impinge on the surface of the agglomerator and are agglomerated into larger droplets which either fall down into the horizontal vessel or are entrained by the gas and taken off into the multicyclone bundle for separation. Similarly, any foam entrained in the gas will be wholly or partly collapsed by the surfaces of the agglomerator.

Within the horizontal vessel 2 the hydrocarbon and water phases separate and are removed from the vessel from respective hydrocarbon and water outlets 15,16. In order to prevent water from flowing through the hydrocarbon outlet a weir 17 is pr vided near the outlet end of the vessel 2, and the water/hydrocarbon interface to the left of the weir (as viewed in the drawing) is maintained below the level of the upper edge of the weir by

controlling the flow of water from the outlet 16. Level sensors 18,19 are provided to determine the position of the water/hydrocarbon interface. Separation of the water from the hydrocarbon is essentially by gravity, although separation can be aided by use of a coalesing pack 20 comprising woven metallic mesh, tilted parallel plates, or opposed corrugated sheets.

Preferably stilling baffles e.g. as illustrated at 21 and 22 are provided in the horizontal vessel to minimise the disturbing effects or surging of process flow and movements occasioned by movement of the separator structure itself, such as would be incurred if the separator was mounted on board a floating production barge or the like. It is particularly preferred that a stilling baffle such as baffle 21, or other suitable means, be provided at the interface of the upper and lower vessels to inhibit movement of the liquid in that area. Movement of the liquid in the remainder of the lower vessel is inhibited because of the small space above the liquid surface aided by the use of optional stilling baffles such as baffle 22.

If desired, the horizontal vessel can be provided with a water jet system for clearing sand and other debris from the bottom of the vessel, sand outlets 24,25 being provided for removing such material from the horizontal vessel.

In use, the space between the liquid level 6 and the top of a horizontal vessel is maintained at a minimum consistent with allowing satisfactory separation of gas bubbles from the liquid within the horizontal vessel. Gas liberated within the horizontal vessel either flows upwardly through the vertical vessel 7, or is taken via a gas balance line 26 to an upper region of the vertical vessel 7 for removal via gas outlet 8. By maintaining a minimum clearance above the liquid in the

horizontal vessel the effects of movement of the support structure and the effects of waves caused by flow surges are minimised, enabling effective separation of oil, liquid, and gas to be carried out in a lighter and more compact separator than was possible with the prior art.

Referring now to Figure 2 a second embodiment of three phase separator is shown, parts corresponding to those of the first embodiment being marked with the same reference numerals. In the Figure 2 embodiment the lower vessel 2 is spherical and the upper vessel 7 is a vertical cylinder mounted centrally atop the lower vessel. A suitable stilling baffle (not shown) is located at the interface of the upper and lower vessels, and a weir (not shown) is provided within the lower vessel between the outlets 15,16. Level sensors 28 control the rate of withdrawl of hydrocarbon and aqueous liquids to maintain the lower vessel substantially completely filled with liquid.

CLAIMS

1. A three phase separator for separating an inlet flow comprising gas, hydrocarbon liquid and aqueous liquid, into gas, hydrocarbon, and aqueous outlets, the separator comprising: a first, lower vessel which in use is substantially filled with liquid and a second, upper, vessel, mounted atop and in communication with the lower vessel, in which liquid/gas disengagement is effected, the maximum cross-sectional area of the upper vessel, measured in the horizontal plane, being smaller than the maximum cross-sectional area of the lower vessel, measured in the horizontal plane.

2. A three phase separator according to claim 1 wherein the inlet flow enters the upper vessel intermediate the top and bottom thereof via an inlet diffuser which directs the inlet flow downwardly within the upper vessel.

3. A three phase separator according to claim 1 or claim 2 wherein the upper portion of the upper vessel is provided with a separator for separating entrained material from the gas flow.

4. A three phase separator according to claim 3 wherein the separator comprises a plurality of multicyclone separators.

5. A three phase separator according to claim 3 or claim 4 wherein a droplet agglomerator is located upstream of the separator.

6. A three phase separator according to claim 5 wherein the agglomerator is located above the inlet diffuser.

7. A three phase separator according to any preceding claim wherein a gas pipe connects the top of the lower vessel to an upper region of the upper vessel.

8. A three phase separator according to any preceding claim wherein the lower vessel contains a plurality of stilling baffles.

9. A three phase separator according to any preceding claim wherein a stilling baffle is provided at the interface of the upper and lower vessels.

10. A three phase separator according to any preceding claim wherein the bottom of the lower vessel includes at least one solid matter outlet and water jet means are provided for moving solid matter from the floor of the vessel to the solid matter outlet.

11. A three phase separator according to any preceding claim wherein a weir extends from the floor of the lower vessel up to an edge below the top of the lower vessel, the aqueous fluid level on the inlet side of the weir being maintained below the level of the weir so that only hydrocarbon liquid crosses the weir.

12. A three phase separator according to any preceding claim wherein the upper vessel is a cylindrical vessel mounted with its axis vertical.

13. A three phase separator according to any preceding claim wherein the lower vessel is a cylindrical vessel with its axis horizontal.

14. A three phase separator according to any of claims 1 to 12 wherein the lower vessel is spherical.

15. A three phase separator substantially as herein described with reference to the accompanying drawing.

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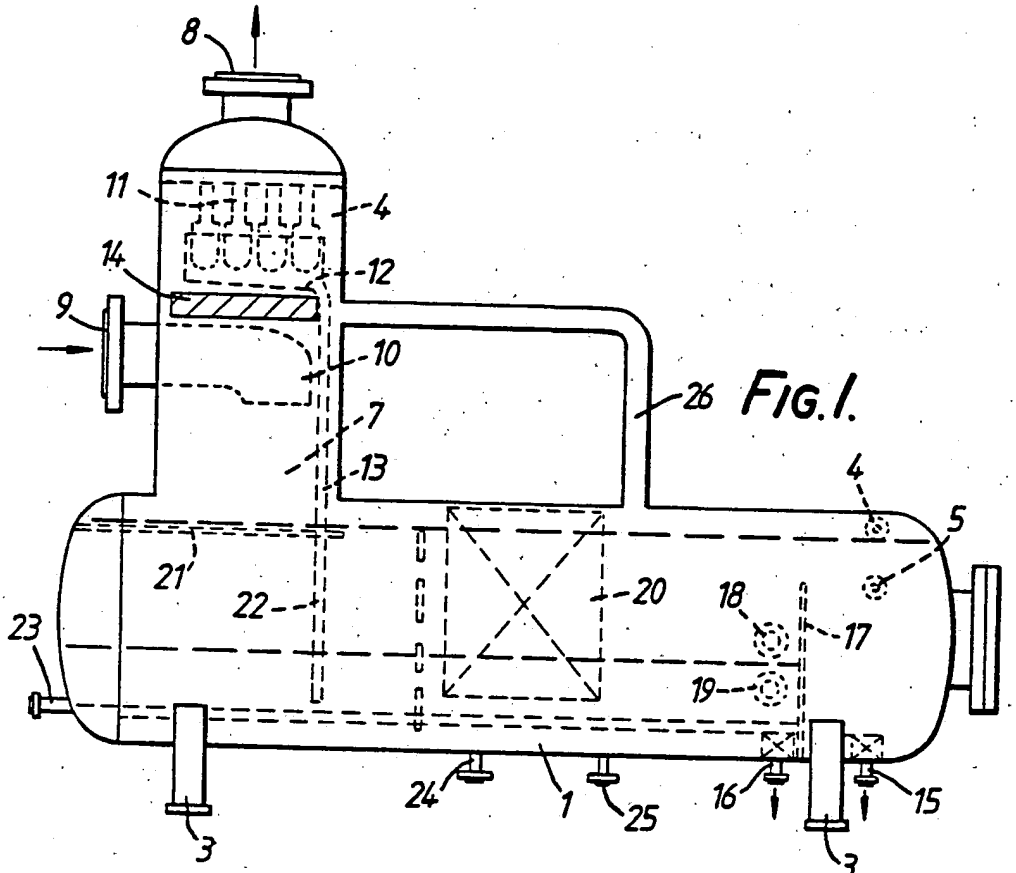
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FIG. 1.

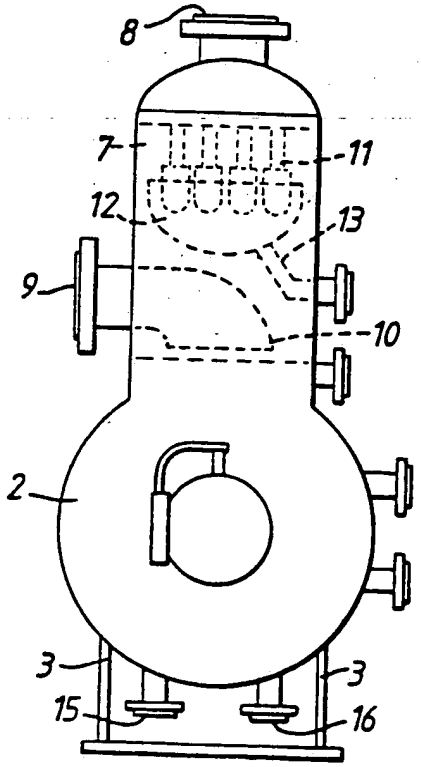
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FIG. 2.

INTERNATIONAL SEARCH REPORT

International Application No PCT/GB 85/00533

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC[4]: E 21 B 43/34; B 01 D 45/02

II. FIELDS SEARCHED

Minimum Documentation Searched [7]	
Classification System	Classification Symbols
IPC[4]	E 21 B 43/00 B 01 D 45/00

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category [10]	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
X	US, A, 3312044 (A.W. McCARTER) 4 April 1967, see figures 1-4; column 2, line 20 - column 6, line 33	1,2,3,8,12, 13
A	EP, A, 0018168 (BRITISH PETROLEUM COMP.) 29 October 1980, see figures 1-4; page 6, line 20 - page 7, line 21	1,2,3,7,9
A	DE, B, 1271655 (D.A. SILLERS) 4 July 1968, see figure 1; column 3, line 27 - column 4, line 16	4
A	US, A, 3360903 (P.E. MEYER) 2 January 1968	

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* Special categories of cited documents: [10]

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IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
21st February 1986	18 MAR 1986
International Searching Authority	**Signature of Authorized Officer**
EUROPEAN PATENT OFFICE	M. VAN MOL

Form PCT/ISA/210 (second sheet) (January 1985)

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON

INTERNATIONAL APPLICATION NO. PCT/GB 85/00533 (SA 11323)

This Annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on 07/03/86

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Patent document cited in search report	Publication date	Patent family member(s)		Publication date
US-A- 3312044		None		
EP-A- 0018168	29/10/80	AU-A-	5726280	16/10/80
		JP-A-	55139490	31/10/80
		CA-A-	1136061	23/11/82
		AU-B-	536655	17/05/84
DE-B- 1271655		GB-A-	1202274	12/08/70
		FR-A-	1439604	
US-A- 3360903		None		